

XXXII.—On the young state of *Ophiocoma rosula*, and on the Form and Development of the Spines of this Species. By T. H. STEWART.

[With a Plate.]

ON looking over a maundful of trawl-refuse lately, which was obtained by the fishermen from off the Plymouth coast, and principally from near the Eddystone lighthouse, I found fine specimens of *Salicornaria farciminoides*, around the lower portions of many of which a parasitic sponge\* was attached. On tearing apart this sponge to look for the form of the spicula, a number of exceedingly small starfishes were found on it. When I first saw them, I fancied that they were young *Ophiocoma rosulae*, and subsequent investigation has proved this to be the case; although on looking at them afterwards with a low power (100 diam.) under the microscope, I was, from the very peculiar form of the spines, led to think them a new species of *Ophiocoma*.

It is an interesting and curious fact, that not only have these young starfishes been found in deep water, as at the Eddystone, which is about 50 fathoms, but also in pools left by the receding tide in limestone rocks under the "Hoe," Plymouth, and in this case also crawling on a soft sponge; and I have not hitherto observed them in contact with any harder material.

The fact of their having been found in two such different localities proves that this *Ophiocoma* spawns both in deep and shallow water. It is also remarkable that they should in each case have been found on sponge, and that those from the deep-water locality were never seen to crawl on the Zoophyte, but were found exclusively on the sponge at the base.

They were not stalked, as the late lamented Prof. Edward Forbes fancied the young of the *Ophiocoma* might be (however, they may have passed this period), but could crawl about at pleasure, though they did not seem to be very active, and seldom moved unless intentionally disturbed, and were crowded chiefly in the corners of the sponge.

None of them, however, when roughly handled, showed any tendency to break off their arms.

The largest of them did not exceed one-eighth of an inch in diameter, including both the rays and disk.

Their appearance when alive, under the low power of a microscope, was a most interesting sight; and by employing the polarizing apparatus, the colours that the various parts, more especially the spines, exhibited, made them tenfold more beautiful.

\* On submitting this sponge to Mr. Bowerbank, whose judgement on such subjects is always appreciated, he not only kindly examined it, but also pronounced it to be a new sponge.

The *disk* in this young state is more pentagonal than in the adult animal. It is of a deep yellowish-brown or purple colour, and it was this part that rendered the starfish evident on the sponges.

The entire starfish was very transparent, so that the movements of the stomach and parts within could be distinctly seen under an inch power (100 diam.).

The disk was spinous, but had the spines more irregularly arranged than in the full-grown starfish. The forms of the spines are those depicted in Pl. XV. fig. 4. They were most distinctly seen on the borders of the disk, between the rays, and all of them had a like typical form, though some differed from others on the same starfish in slight particulars, as the length of the stalk bearing three spinules or secondary spines.

The base of these spines is a flattened disk, and somewhat circular in form; immediately above the base is a contraction, and it then shows a perforated structure; the holes producing these perforations are regular and arranged in the central line. The length of the stalk is rather *less* than half the length of the whole spine. The spine then separates into three prongs or spinules, which are rather *more* than half the length of the whole spine.

These spinules in some spread out wider apart than in others, and in one they approached each other again at the tip. All the spines of the disk are of this form, and they retain the same in the adult *O. rosula*, but as a general rule they are rather longer in the stalk.

If the animal be turned on its back, and examined with a power of 100 diameters by transmitted light, the outline of the stomach is seen to be of a pentagonal form, and has *five* lateral attachments to the inner surface of the body, which are situate between the rays. The outline of the stomach is dark and well defined, and appears like lines passing from one point of attachment to the other; it might be taken at first sight for the nervous system, were it not for the fact, that the meeting of the lines where the nervous threads to the rays would be given off, takes place *between* the rays, and not at their base, as would be the case if it were the nervous system.

The contractions of the stomach were very evident; sometimes the orifice was completely closed, and was then central, and the radiating muscular fibres could be detected. At other times it was dilated quite to the lines indicating the outline of the stomach before mentioned, and at another time much to one side.

The dilating muscle possesses a great deal more power than the contracting one, as the motion of the former was considerably quicker effected.

Within the stomach were seen ten attached club-shaped bodies, similar to the membranous tentacula of the arms, which were in constant motion; two were attached between each dark bundle of spines, or oral cluster, which are situated at the mouth of the disk. They seemed to be contractile, and to draw back to the sides of the stomach, assuming a somewhat globular form.

But what I desire more especially to direct attention to are the spines on the rays; these may be said to be of three kinds:—1st, those which may be termed palmate or basal spines of the ray, or the first set at the part where the ray springs from the disk (fig. 4); 2ndly, the reticulated spines (fig. 5); 3rdly, the hooked spines (fig. 6).

The first set are shaped somewhat like a hand with the fingers spread out, only minus a thumb: as the greater number have only four spinules, or secondary spines, these are longer and more widely separated from each other than in the second set, and consequently the whole spine is broader. It has a broad, thick, and rounded base, and immediately above the base the spine is narrowed, and then becomes wider again so as to form a constriction at this part; and in fact the spine may be divided into three parts,—the base, the body constricted at the lower part, and the spinous extremities.

The palmate portion of the spine is pierced with irregular holes. The entire spine is covered with a delicate membrane, and this connects the spinules, forming a web, thus giving the spine a strong resemblance to the foot of a frog. In other parts of the spine this membrane is closely attached to it; and where the webbing occurs, the two parts covering the upper and lower portions of the spine come in contact, and thus as it were enclose it in a membranous sac. This membrane is destroyed by boiling in caustic potash.

The spines of the *second* set may be said to occupy rather more than the lower two-thirds of the ray on the under side, and almost the whole of the upper. They are more irregular in their form than the last, especially as regards the number, form, and arrangement of the spinules. Their base is not so rounded and the constriction not so well marked as in the first set. In fact, the spine altogether is not so symmetrical and constant in its shape as either of the others, and is evidently in a transition state, for no two of these spines were alike in form, whilst the first or palmate, and the third or hooked, never varied to any marked extent. In the adult animal, the hooked spines still preserve the form that they had in their young condition, though of course they are proportionately larger.

As the second set of spines grow, they become more regular in form, and the spinules, or what are then the rough serrations,



are placed at regular distances, and the spine becomes symmetrical, and assumes that beautiful form depicted in fig. 8; and figured by Prof. E. Forbes, who says, "the lightness and beauty of which might serve as a model for the spire of a cathedral."

The most interesting of all these spines are the *third* set, or hooked ones, which occupy the tip and a portion of the under surface of the extremities of the rays. They are not unlike reaping-hooks, only they have a secondary hook below, just at the point of the junction of the handle and blade. They also have a tubercle below this on the *handle*, but this is never formed into a decided hook like the other two above. It was the existence of these hooked spines that led me to fancy the young *O. rosula* a new *Ophiocoma*. But in order to be quite sure on the subject, and not to make new species without careful investigation, I boiled some older *O. rosulae* in caustic potash; and on examining the result, I found the same hooked spines to be present.

By examining and comparing the spines of these young with those of an adult *O. rosula*, it will be noticed that the hooked ones do not grow in the same proportion as the rest; for in the adult, though they still keep the same form, they are very small in comparison to the other spines, whereas in the young they are of the same size and serve an important office, viz. enabling these young and feeble starfish to gain a firmer hold of the substance on which they crawl, so that they are not drifted off by every slight force to which they are exposed; and indeed I found that while they were alive it required a considerable effort to separate them from their attachment.

It would appear therefore that these hooks are specially provided for the young condition of the starfish, and is another beautiful instance how Nature modifies parts of the body to meet the special requirements of animals under varying circumstances. These hooked spines have the same rounded base and constriction as the others, and they then form the sickle-like termination.

Parallel with this terminal hook in about the middle of the spine another is formed, which is not so long or large as the terminal one; and at an equal distance below this second hook is a little tubercle, which is not developed into a hook, but is perforated with small holes, as also is the base, giving it when only slightly magnified a granular appearance.

I have never found more than two hooks on a single spine, except in one adult animal, where on one of the spines there were three; but the lowest near the base was very rudimentary.

All the spines are covered with the animal membrane before

